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Eccentric Loading Formulas

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List of 18 Eccentric Loading Formulas

Eccentric Loading

1) Critical Buckling Load given Deflection in Eccentric Loading

Open Calculator

fx $$P_c = \frac{P \cdot (4 \cdot e_{load} + \pi \cdot \delta)}{\delta \cdot \pi}$$

ex $$55.41737\text{kN} = \frac{9.99\text{kN} \cdot (4 \cdot 2.5\text{mm} + \pi \cdot 0.7\text{mm})}{0.7\text{mm} \cdot \pi}$$

2) Cross-Sectional Area given Radius of Gyration in Eccentric Loading

Open Calculator

fx $$A_{cs} = \frac{I}{k_G^2}$$

ex $$13.37693\text{m}^2 = \frac{1.125\text{kg}\cdot\text{m}^2}{(0.29\text{mm})^2}$$

3) Cross-Sectional Area given Total Stress is where Load doesn't lie on Plane

Open Calculator

fx $$A_{cs} = \frac{P}{\sigma_{total} - \left(\left(\frac{e_x \cdot P \cdot c_x}{I_y}\right) + \left(\frac{e_y \cdot P \cdot c_y}{I_x}\right)\right)}$$

ex $$13.22767\text{m}^2 = \frac{9.99\text{kN}}{14.8\text{Pa} - \left(\left(\frac{4 \cdot 9.99\text{kN} \cdot 15\text{mm}}{50\text{kg}\cdot\text{m}^2}\right) + \left(\frac{0.75 \cdot 9.99\text{kN} \cdot 14\text{mm}}{51\text{kg}\cdot\text{m}^2}\right)\right)}$$

4) Cross-Sectional Area given Total Unit Stress in Eccentric Loading

Open Calculator

$$A_{cs} = \frac{P}{f - \left(\left(P \cdot c \cdot \frac{e}{I_{neutral}}\right)\right)}$$

$$0.532035\text{m}^2 = \frac{9.99\text{kN}}{100\text{Pa} - \left(\left(9.99\text{kN} \cdot 17\text{mm} \cdot \frac{11\text{mm}}{23\text{kg}\cdot\text{m}^2}\right)\right)}$$

5) Deflection in Eccentric Loading

Open Calculator

$$\delta = \frac{4 \cdot e_{load} \cdot \frac{P}{P_c}}{\pi \cdot \left(1 - \frac{P}{P_c}\right)}$$

$$0.739343\text{mm} = \frac{4 \cdot 2.5\text{mm} \cdot \frac{9.99\text{kN}}{53\text{kN}}}{\pi \cdot \left(1 - \frac{9.99\text{kN}}{53\text{kN}}\right)}$$

6) Distance from XX to outermost fiber given Total Stress where Load doesn't lie on Plane

Open Calculator

$$c_y = \frac{\left(\sigma_{total} - \left(\frac{P}{A_{cs}}\right) - \left(\frac{e_x \cdot P \cdot c_x}{I_y}\right)\right) \cdot I_x}{P \cdot e_y}$$

$$13.90997\text{mm} = \frac{\left(14.8\text{Pa} - \left(\frac{9.99\text{kN}}{13\text{m}^2}\right) - \left(\frac{4 \cdot 9.99\text{kN} \cdot 15\text{mm}}{50\text{kg}\cdot\text{m}^2}\right)\right) \cdot 51\text{kg}\cdot\text{m}^2}{9.99\text{kN} \cdot 0.75}$$

7) Distance from YY to outermost fiber given Total Stress where Load doesn't lie on Plane

Open Calculator

fx $$c_x = \left(\sigma_{total} - \left(\left(\frac{P}{A_{cs}}\right) + \left(\frac{e_y \cdot P \cdot c_y}{I_x}\right)\right)\right) \cdot \frac{I_y}{e_x \cdot P}$$

ex $$14.98345\text{mm} = \left(14.8\text{Pa} - \left(\left(\frac{9.99\text{kN}}{13\text{m}^2}\right) + \left(\frac{0.75 \cdot 9.99\text{kN} \cdot 14\text{mm}}{51\text{kg·m}^2}\right)\right)\right) \cdot \frac{50\text{kg·m}^2}{4 \cdot 9.99\text{kN}}$$

8) Eccentricity given Deflection in Eccentric Loading

Open Calculator

fx $$e_{load} = \left(\pi \cdot \left(1 - \frac{P}{P_c}\right)\right) \cdot \frac{\delta}{4 \cdot \frac{P}{P_c}}$$

ex $$2.366965\text{mm} = \left(\pi \cdot \left(1 - \frac{9.99\text{kN}}{53\text{kN}}\right)\right) \cdot \frac{0.7\text{mm}}{4 \cdot \frac{9.99\text{kN}}{53\text{kN}}}$$

9) Eccentricity w.r.t axis XX given Total Stress where Load doesn't lie on Plane

Open Calculator

fx $$e_y = \frac{\left(\sigma_{total} - \left(\frac{P}{A_{cs}}\right) - \left(\frac{e_x \cdot P \cdot c_x}{I_y}\right)\right) \cdot I_x}{P \cdot c_y}$$

ex $$0.745177 = \frac{\left(14.8\text{Pa} - \left(\frac{9.99\text{kN}}{13\text{m}^2}\right) - \left(\frac{4 \cdot 9.99\text{kN} \cdot 15\text{mm}}{50\text{kg·m}^2}\right)\right) \cdot 51\text{kg·m}^2}{9.99\text{kN} \cdot 14\text{mm}}$$

10) Eccentricity wrt axis YY given Total Stress where Load doesn't lie on Plane

Open Calculator

fx $$e_x = \frac{\left(\sigma_{total} - \left(\frac{P}{A_{cs}}\right) - \frac{e_y \cdot P \cdot c_y}{I_x}\right) \cdot I_y}{P \cdot c_x}$$

ex $$3.995587 = \frac{\left(14.8\text{Pa} - \left(\frac{9.99\text{kN}}{13\text{m}^2}\right) - \frac{0.75 \cdot 9.99\text{kN} \cdot 14\text{mm}}{51\text{kg·m}^2}\right) \cdot 50\text{kg·m}^2}{9.99\text{kN} \cdot 15\text{mm}}$$

11) Load for Deflection in Eccentric Loading

Open Calculator

$$P = \frac{P_c \cdot \delta \cdot \pi}{4 \cdot e_{load} + \pi \cdot \delta}$$

$$9.554225\text{kN} = \frac{53\text{kN} \cdot 0.7\text{mm} \cdot \pi}{4 \cdot 2.5\text{mm} + \pi \cdot 0.7\text{mm}}$$

12) Moment of Inertia about XX given Total Stress where Load doesn't lie on Plane

Open Calculator

$$I_x = \frac{e_y \cdot P \cdot c_y}{\sigma_{total} - \left(\left(\frac{P}{A_{cs}}\right) + \left(\frac{e_x \cdot P \cdot c_x}{I_y}\right)\right)}$$

$$51.33008\text{kg·m²} = \frac{0.75 \cdot 9.99\text{kN} \cdot 14\text{mm}}{14.8\text{Pa} - \left(\left(\frac{9.99\text{kN}}{13\text{m²}}\right) + \left(\frac{4 \cdot 9.99\text{kN} \cdot 15\text{mm}}{50\text{kg·m²}}\right)\right)}$$

13) Moment of Inertia about YY given Total Stress where Load doesn't lie on Plane

Open Calculator

$$I_y = \frac{e_x \cdot P \cdot c_x}{\sigma_{total} - \left(\left(\frac{P}{A_{cs}}\right) + \left(\frac{e_y \cdot P \cdot c_y}{I_x}\right)\right)}$$

$$50.05523\text{kg·m²} = \frac{4 \cdot 9.99\text{kN} \cdot 15\text{mm}}{14.8\text{Pa} - \left(\left(\frac{9.99\text{kN}}{13\text{m²}}\right) + \left(\frac{0.75 \cdot 9.99\text{kN} \cdot 14\text{mm}}{51\text{kg·m²}}\right)\right)}$$

14) Moment of Inertia given Radius of Gyration in Eccentric Loading

Open Calculator

$$I = \left(k_G^2\right) \cdot A_{cs}$$

$$1.0933\text{kg·m²} = \left((0.29\text{mm})^2\right) \cdot 13\text{m²}$$

15) Moment of Inertia of Cross-Section given Total Unit Stress in Eccentric Loading

Open Calculator

$$I_{neutral} = \frac{P \cdot c \cdot e}{f - \left(\frac{P}{A_{cs}}\right)}$$

$$18.82597\text{kg·m}^2 = \frac{9.99\text{kN} \cdot 17\text{mm} \cdot 11\text{mm}}{100\text{Pa} - \left(\frac{9.99\text{kN}}{13\text{m}^2}\right)}$$

16) Radius of Gyration in Eccentric Loading

Open Calculator

$$k_G = \sqrt{\frac{I}{A_{cs}}}$$

$$0.294174\text{mm} = \sqrt{\frac{1.125\text{kg·m}^2}{13\text{m}^2}}$$

17) Total Stress in Eccentric Loading when Load doesn't lie on Plane

Open Calculator

$$\sigma_{total} = \left(\frac{P}{A_{cs}}\right) + \left(\frac{e_x \cdot P \cdot c_x}{I_y}\right) + \left(\frac{e_y \cdot P \cdot c_y}{I_x}\right)$$

$$14.81323\text{Pa} = \left(\frac{9.99\text{kN}}{13\text{m}^2}\right) + \left(\frac{4 \cdot 9.99\text{kN} \cdot 15\text{mm}}{50\text{kg·m}^2}\right) + \left(\frac{0.75 \cdot 9.99\text{kN} \cdot 14\text{mm}}{51\text{kg·m}^2}\right)$$

18) Total Unit Stress in Eccentric Loading

Open Calculator

$$f = \left(\frac{P}{A_{cs}}\right) + \left(P \cdot c \cdot \frac{e}{I_{neutral}}\right)$$

$$81.99151\text{Pa} = \left(\frac{9.99\text{kN}}{13\text{m}^2}\right) + \left(9.99\text{kN} \cdot 17\text{mm} \cdot \frac{11\text{mm}}{23\text{kg·m}^2}\right)$$

Variables Used

- A_{cs} Cross-Sectional Area *(Square Meter)*
- c Outermost Fiber Distance *(Millimeter)*
- c_x Distance from YY to Outermost Fiber *(Millimeter)*
- c_y Distance from XX to Outermost Fiber *(Millimeter)*
- e Distance from Load applied *(Millimeter)*
- e_{load} Eccentricity of Load *(Millimeter)*
- e_x Eccentricity with respect to Principal Axis YY
- e_y Eccentricity with respect to Principal Axis XX
- f Total Unit Stress *(Pascal)*
- I Moment of Inertia *(Kilogram Square Meter)*
- $I_{neutral}$ Moment of Inertia about Neutral Axis *(Kilogram Square Meter)*
- I_x Moment of Inertia about X-Axis *(Kilogram Square Meter)*
- I_y Moment of Inertia about Y-Axis *(Kilogram Square Meter)*
- k_G Radius of Gyration *(Millimeter)*
- P Axial Load *(Kilonewton)*
- P_c Critical Buckling Load *(Kilonewton)*
- δ Deflection in Eccentric Loading *(Millimeter)*
- σ_{total} Total Stress *(Pascal)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Force** in Kilonewton (kN)
  Force Unit Conversion
- Measurement: **Moment of Inertia** in Kilogram Square Meter (kg·m²)
  Moment of Inertia Unit Conversion

Check other formula lists

- **Beams Formulas**
- **Eccentric Loading Formulas**

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